DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application]This invention relates to the lighting system used for the backlighting (back light) of the received type liquid crystal display of light.

[0002]

[Description of the Prior Art]Conventionally, it is divided roughly into a direct bottom part method and the light guide method which used the light guide plate by the lighting system (back light system) of liquid crystal displays, such as a laptop PC.

[0003]

(1) The light reflector 3 for the lighting system for liquid crystals of a direct bottom part reflecting the light which allots the tubular light source 2 of two or more cold cathode tubes, a hot cathode tube, etc., emits from the tubular light source 2, and goes to the back directly under the liquid crystal display panel 1, and leading it to the front like drawing 5, In order to make cotton intermediary homogeneity use luminosity of an illuminated face as a presence object between the tubular light source 2 and the liquid crystal display panel 1, the diffusion board 4 which consists of a synthetic resin board of the opalescence which has the light scattering effect is formed.

[0004]

(2) The lighting system for liquid crystals of a light guide method, In addition to the above-mentioned light reflector 3 and the diffusion board 4, the light guide plate 5 which consists of acrylic resin, such as polymethylmethacrylate (PMMA) excellent in the light transmittance state, is formed like drawing 6 and 7, The tubular light source 2 is allotted to the both sides or one side of the light guide plate 5, the luminosity unevenness of the whole field is reduced, and display quality is improved. Seven are a tubular light source reflection film which raises the angle of beam spread to the light guide plate of the tubular light source 2 among drawing 6

among the reflector to which six raise the angle of beam spread to the light guide plate of the tubular light source 2, and drawing 7.

[0005]

[Problem(s) to be Solved by the Invention]However, in the lighting system for liquid crystals of the conventional direct bottom part. By using the writing curtain (not shown) which reflected the light emitted from the tubular light source 2 with the light reflector 3, and printed the dot pattern of aluminum to the PET film further, in order to attain luminosity equalization on the diffusion board 4. It can be made to equalize the field luminosity on the diffusion board 4 to some extent. However, the muscle of the tubular light source 2 is visually checked on the diffusion board 4, lamp unevenness surely occurs directly under the tubular light source 2, and a rope is intermediary **** to the fall of the display properties of a lighting system.

[0006]In the lighting system for liquid crystals of a light guide method, luminosity equalization on the diffusion board 4 by giving printing patterns, such as white system ink for light scattering, to the undersurface and the upper surface of the light guide plate 5 line intermediary ****, It is difficult as luminosity equalization (for example, 90% of uniformity ratio of illuminance) on the diffusion board 4 becomes a high-intensity back light with dispersion in DOTSUTO of a printing pattern, etc., and it is ******.

[0007]From the above thing, luminosity equalization on a diffusion board was desired, and an especially complicated structure was not taken, but a method which equalizes luminosity was desired by devising the shape of a light reflector.

[0008]This invention aims at offer of the lighting system for liquid crystals which can realize luminosity equalization on a diffusion board only in the shape of a light reflector in view of an aforementioned problem.

[0009]

[Means for Solving the Problem]The tubular light source 11 in which a business solution means by this invention claim 1 illuminates the liquid crystal display panel 10 from back like drawing 1 and 2, Have the light reflector 12 made to reflect irradiation light to back from this tubular light source 11 in the liquid crystal display panel 10 side, and said tubular light source 11 is allotted outside the effective display area S of the liquid crystal display panel 10, and said light reflector 12, It has theta 1 for an angle of a line and the perpendicular direction which tie a tube-axial center and each reflective spot of L1 and the light source 11 for distance of the each reflective spot and tube-axial center of the tubular light source 11 to make, has a relation of a following formula for a constant as C_1 and C_2, and curves.

[0010]The reflection film 13 in which a business solution means by L1 = $(1/C_1)$ and cos (theta1+C_2) this invention claim 2 restricts an angle of beam spread of light towards the light reflector 12 in pipe inner skin of the tubular light source 11 according to claim 1 is formed.

[0011]Like drawing 3 and 4, a business solution means by this invention claim 3 illuminates the liquid crystal display panel 10 from back, and it ****** and the tubular light source 11, It has the light guide plate 21 arranged in parallel with the liquid crystal display panel 10 so that light from the tubular light source 11 may be led to the liquid crystal display panel 10, Said tubular light source 11 is allotted to the light incidence end 21a of the light guide plate 21, and a rear face of said light guide plate 21, In a lighting system for liquid crystals made into the reflector 21b which reflects in the front light which he follows back within the light guide plate 21, Per each irradiation light line, if an angle of refraction in a light incidence end of L2 and each irradiation light line is set to 90 degree-theta2 and a constant is made into C_1 and C_2, the reflector 21b of said light guide plate 21 will have a relation of a following formula, and will curve distance from a probe index of the light incidence end 21a to a reflective spot of the reflector 21b.
[0012]The reflection film 13 in which a business solution means by L2 = $(1/C_1)$ and cos (theta2+C_2) this invention claim 4 restricts an angle of beam spread of light towards the light incidence end 21a of the light guide plate 21 in pipe inner skin of the tubular light source 11 according to claim 3 is formed.
[0013]
[Function]In the business solution means by above-mentioned claims 1 and 2, the light from the tubular light source 11 has an angle of beam spread restricted by the reflection film 13, and the all are irradiated by the light reflector 12. And it is reflected in the front by the light reflector 12, and light is irradiated by the rear face of the liquid crystal display panel 10.
[0014]At this time, the illumination of all the reflective spots on the light reflector 12 becomes equal, and becomes uniform [the luminosity of the illuminated face in the effective display area S].
[0015]In the business solution means by claims 3 and 4, the light from the tubular light source 11 has an angle of beam spread restricted by the reflection film 13, and the all are irradiated by the light incidence end 21a of the light guide plate 21. And light advances inside the light guide plate 21 from the light incidence end 21a.
Then, it reflects in the front in the reflector 21b, and the rear face of the liquid crystal display panel 10 glares.

[0016]At this time, the illumination of all the reflective spots on the reflector 21b becomes equal, and becomes uniform [the luminosity of the illuminated face in the effective display area S].
[0017]
[Example]
(The first example) The sectional view of the lighting system for liquid crystals which drawing 1

shows the first example of this invention, and drawing 2 are the figures showing an optical path similarly.

[0018]Like a graphic display, the liquid crystal display of this example is as [which does not use a light guide plate] a direct bottom part.

It has the light reflector 12 made to reflect in the liquid crystal display panel 10 side the light from the tubular light source 11 and this tubular light source 11 of the couple which illuminates the liquid crystal display panel 10 from back.

[0019]The cold cathode tube and hot cathode tube of the straight pipe type [tubular light source / 11 / said / each] as a line tubular light source are used. The reflection film 13 which restricts the angle of beam spread of light towards said light reflector 12 is formed in the pipe inner skin of this tubular light source 11, and it is considered as the aperture tube. After applying the existing fluorescence material to all the fields of pipe inner skin, this reflection film 13 removes the field to which it points in the light reflector 12 from a tube-axial center, and is formed. This tubular light source 11 is allotted outside the effective display area S of the liquid crystal display panel 10.

[0020]As for said light reflector 12, the metal plate etc. whose reflectance is about 90% are used. The sectional shape of this light reflector 12 is curving in the shape of [which was projected back] a circle in order to make the illumination of all the reflective spots equal.

It has an angle of L1, and each reflective spot and the perpendicular direction of the tubular light source 11 to make for the distance of the each reflective spot and tube-axial center of the tubular light source 11, and always has a relation of a following formula for theta 1 and arbitrary constants as C_1 and C_2.

[0021]L1 = $(1/C_1)$ and cos $(\text{theta}1+C_2)$ -- (1) Here, explain the view of (1) type. First, the following (a) and (b) are set up as conditions for making the illumination of all the reflective spots equal.

[0022](a) the tubular light source 11 -- a line -- since it is tubular, luminous flux density is in inverse proportion to the distance L from a tubular light source.

[0023](b) Since the illumination of the reflector of the light reflector 12 is proportional to the luminosity, even if it sees from which direction, make it into the field (henceforth the perfect diffuse surface) which shows the same luminosity.

[0024]In reflection in the perfect diffuse surface, conditions for the luminosity of the perfect diffuse surface to become uniform based on the above (a) and (b) are searched for noting that an ideal form without attenuation of light is assumed. About the beam of light G1 to the direction in which only theta carries out a phase from it being perpendicular like drawing 2, about the distance from the tube-axial center of the tubular light source 11 to the perfect

diffuse surface, if the angle of L, the beam of light G1, and the perfect diffuse surface to make is set to alpha, illumination is proportional to cos alpha/L. Here, considering the beam of light G2 irradiated only with minute angle dtheta by carrying out a phase from the angle theta, the distance from the tube-axial center of the tubular light source 11 to the perfect diffuse surface serves as (L+dL). The distance of the reflective spot P1 in the perfect diffuse surface of the beam of light G1 and the beam of light G2 is set to L-dtheta. Therefore, a differential equation like (2) equations is materialized.
[0025]
[Equation 1]

$$\frac{\cos\alpha}{L}=\frac{1}{L}\cdot\frac{L\cdot d\theta}{\sqrt{(dL)^2+(Ld\theta)^2}}=\frac{1}{\sqrt{(dL/d\theta)^2+L^2}}=C\ (定数)$$

$$\therefore\ \left(\frac{dL}{d\theta}\right)^2+L^2=\frac{1}{C^2}\quad\cdots(2)$$

[0026](2) If a formula is solved, it will become like (1) type. This makes the position of a tubular light source the starting point, and expresses the circle which passes along the starting point. The example actually applied to the lighting system shows drawing 1 this solution. If it has such composition, without being dependent on the distance L from the tubular light source 11, the light reflector 13 as the perfect diffuse surface always serves as the same luminosity, and will not be based on inclination of the perfect reflecting diffuser 13, but can obtain uniform illumination. Therefore, when a liquid-crystal-display side is seen from a front direction, the uniform display of luminosity equivalent to the case where it glares by the field tubular light source of uniform luminance can be attained.
[0027](The second example) The sectional view of the lighting system for liquid crystals which drawing 3 shows the second example of this invention, and drawing 4 are the figures showing the light incidence end of a light guide plate, and the optical path in the inside similarly.
[0028]Like a graphic display, the lighting system for liquid crystals of this example is provided with the light guide plate 21 arranged in parallel with the liquid crystal display panel 10 so that the liquid crystal display panel 10 may be illuminated from back and the light from ******, the tubular light source 11, and the tubular light source 11 may be led to the liquid crystal display panel 10.
[0029]The same aperture type line tubular light source as the first example is used, and said each tubular light source 11 is allotted near light incidence end 21a of the light guide plate 21 out of the effective display area S of the liquid crystal display panel 10. The same reflection film 13 as the first example that restricts the angle of beam spread of light towards the light incidence end 21a of said light guide plate 21 is formed in the pipe inner skin of this tubular

light source 11. About the radius of the tubular light source 11, in the distance of r, the tubular light source 11, and the light incidence end 21a of the light guide plate 12, the angle of aperture phi of this reflection film 13 (aperture angle) sets the width dimension of d and the light guide plate 21 to t, and becomes like (3) types.

[0030]phi=tan $^{-1}$ {t/(r+d)} -- (3) -- as for said light guide plate 21, the acrylic resin of translucency, etc. are used. The rear face of said light guide plate 21 is made into the reflector 21b which reflects in the front the light which he follows back within the light guide plate 21. The total internal reflection point of this reflector 21b always has a relation of (4) types, and is curving.

[0031]L2 = (1/C_1) and cos (theta2+C_2) (4) --It corrects, The distance from the probe index of the light incidence end 21a to the reflective spot of the reflector 21b, C_1, and C_2 show arbitrary constants per each irradiation light line, and L2 is setting the angle of refraction in the light incidence end of each irradiation light line to 90 degree-theta2.

[0032]Here, the view of (4) types is explained. The width dimension of d and the light guide plate 21 is set [the radius of the tubular light source 11] to t for r, the tubular light source 11, and the distance to the light incidence end 21a of the light guide plate 21, and it is as follows when it asks for the shape equation of the reflector 12b as the perfect diffuse surface at the time of making the tube-axial center of the tubular light source 12 into the starting point.

[0033]Like drawing 4, the left-hand side tubular light source 11 is chosen as the starting point, and it is ******. Coordinates (r+d, - (r+d) and tan (90 degree-thetai)) of the position with which the course of the beam of light of the angle which the perpendicular direction and thetai make collides by the light incidence end 21a of the light guide plate 21 considering the tube-axial center of the tubular light source 11 as the starting point (0, 0), i.e., the position in which a beam of light enters into the light guide plate 21,

It becomes. Next, by the position coordinate by which a beam of light enters into the light guide plate 21, the refractive index of the light guide plate 21 as n (for example, PMMA resin n= 1.49) with a Snell's law. Light refracts and enters into the light guide plate 21, and a following formula is materialized between the angles of refraction (namely, 90 degree-theta2) corresponding to an incidence angle (90 degree-thetai).

[0034]

[Equation 2]

$$\frac{\sin(90^\circ-\theta 2)}{\sin(90^\circ-\theta i)}=\frac{1}{n}$$

$$\therefore \theta 2=90^\circ-\sin^{-1}\left(\frac{1}{n}\sin(90^\circ-\theta i)\right) \cdots (5)$$

[0035]then -- as opposed to each thetai (light emitted from a tubular light source lamp) -- each theta2 (light which advances the inside of a transparent material) -- (5) types -- therefore, it will correspond and what is necessary will be just to set up the shape of the reflector 21b so that the light path length of the light which advances the inside of the light guide plate 21 in that case may be set to L (1) Guess from a formula, [0036]

[Equation 3]

$$L=\frac{1}{C_1}\cdot\cos(\theta 2+C_2)$$

[0037]It becomes. The coordinates (x, y) corresponding to each theta2 [of a reflector] of 21b will be searched for with a following formula.

[0038]

[Equation 4]

$$x=(r+d)+\frac{1}{C_1}\cdot\cos(\theta 2+C_2)\cdot\sin\theta 2 \quad \cdots (6)$$

$$y=-(r+d)\cdot\tan[\sin^{-1}\{n\cdot\sin(90^\circ-\theta 2)\}]-\frac{1}{C_1}\cdot\cos(\theta 2+C_2)\cdot\cos\theta 2 \quad \cdots (7)$$

$$\theta 2=90^\circ-\sin^{-1}\left(\frac{1}{n}\cdot\sin(90^\circ-\theta i)\right)$$

[0039]If (6) or (7) formula is arranged, [0040]

[Equation 5]

$$\{x-(r+d)\}^2+[y+(r+d)\cdot\tan[\sin^{-1}\{n\cdot\sin(90^\circ-\theta 2)\}]]^2$$

$$=\frac{1}{C_1{}^2}\{\cos(\theta 2+C_2)\}^2\cdot\sin^2\theta 2+\frac{1}{C_1{}^2}\{\cos(\theta 2+C_2)\}^2\cdot\cos^2\theta 2$$

$$=\frac{1}{C_1{}^2}\{\cos(\theta 2+C_2)\}^2 \quad \cdots (8)$$

[0041](8) A formula centers on coordinates (r+d, -(r+d) tan [$\sin^{-1}$ {n-sin (90 degree-theta2)}]) to each thetai and theta 2. It is shown that the shape which put in a row the circle which makes a radius {$1/C_1$, and cos (theta2+C_2)} serves as the perfect diffuse surface (21b in drawing 4).

[0042]The tubular light source 11 of the right example shown in drawing 3 is chosen as the starting point, and a line intermediary also becomes the same formula.

[0043]As mentioned above, for a start, even if the second example does not use the light scattering means of white ink, such as a diffusion board, a writing curtain or TiO_2, and $BaSO_4$, etc., The luminosity of the illuminated face of the liquid crystal display panel 10 can be equalized only in the shape of the reflector 21b of the light reflector 12 or the light guide plate 21.
[0044]As for this invention, it is needless to say that it is not limited to the above-mentioned example and many corrections and change can be added to the above-mentioned example within the limits of this invention.
[0045]For example, in each above-mentioned example, although the tubular light source 11 was made into two, it is good also as composition which received one tubular light source the side edge neighborhood of one side. Generally a display panel can be used [an electrochromic display panel, other display panels, and] widely besides a liquid crystal display panel.
[0046]
[Effect of the Invention]According to this invention claims 1 and 3, even if the illumination of all the reflective spots on the reflector of a light reflector or a light guide plate becomes equal and it does not use the light scattering means of a diffusion board, a writing curtain, etc., equalization of the luminosity of an illuminated face can be attained. Therefore, part mark can be reduced, a work process can be simplified and it becomes a thing suitable for mass production.
[0047]According to claims 2 and 4, it can irradiate with the light of a tubular light source effective in a light reflector or a light guide plate, and when the luminosity of an illuminated face may be raised, there is the ******** effect when.

[Translation done.]